AKBP 6: SC Resonators

Zeit: Dienstag 13:45–16:15 Raum: BZ.08.06 (HS 1)

AKBP 6.1 Di 13:45 BZ.08.06 (HS 1)

Status and running experience of the SRF gun at HZDR — •rong xiang, andre arnold, pengnan lu, petr murcek, jochen teichert, and hannes vennekate — Helmholtz Zentrum Dresden Rossendorf, 01328 Dresden

In order to achieve a high average current up to 1 mA with a low emittance of 1 mm mrad at 77 pC, an improved SRF gun has been installed and commissioned at HZDR since 2014. This new gun replaces the first 3.5-cell SRF gun at the superconducting linear accelerator ELBE which had been in operation since 2007. The new gun has been tested first with a Cu photocathode. The RF performance of the niobium cavity has been evaluated, the transverse and longitudinal beam parameters for low charge bunches have been measured, and the first beam has been guided into the ELBE beamline. The photocathode transfer system is also installed for the first high current beam test in 2015. In this contribution the status of the gun and the results of this first measurement period will be presented in detail.

AKBP 6.2 Di 14:00 BZ.08.06 (HS 1)

Transverse Emittance Compensation — •H. Vennekate[1,2], A. Arnold[1], T. Kamps[3], P. Kneisel[4], P. Lu[1,2], P. Murcek[2], T. Jochen[2], and R. Xian[2] — [1]TU Dresden — [2]HZDR — [3]HZB — [4]JLab

Superconducting RF injectors are promising candidates for the particle sources of future accelerators. While machines like high power free electron lasers or energy recovery linacs are planned to be operated with large duty factors, or even continuous wave mode, to increase the beam intensity, they also demand high beam quality. As this is already determined at the very start of the generation of each particle bunch, the concept of an SRF gun becomes appealing. Transverse Emittance marks the beam quality which is of tremendous relevance for all beam optics and further more sets the level of angular resolution of any scattering experiment performed with the beam. Several concepts to enhance this quality with the lately comissioned Rossendorf SRF Gun II have been presented in recent year's conferences. The talk will summarize the expended efforts, discuss some of the reflections on installation and operation of the used tools and present preliminary results of the recent achievements.

AKBP 6.3 Di 14:15 BZ.08.06 (HS 1)

A Method for Quality Factor Measurements of the S-DALINAC Superconducting Cavities* — •Ruben Grewe, Christoph Burandt, Florian Hug, Thorsten Kürzeder, and Norbert Pietralla — Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, Germany

The S-DALINAC is a recirculating superconducting linear electron accelerator designed for beam energies of up to 130 MeV. For acceleration it uses 20-cell niobium cavities that are operated at 2 K. While operational experience showed that the design electric field gradient of 5 MV/m can be reached and exceeded, it was found that the quality factor is more than two times worse than the design value of $3 \cdot 10^9$. This results in more power being dissipated into the liquid helium bath which limits the electric field gradient for cw operation. For the assessment of q-factor improvements and for monitoring of q-factor variance over time, an *in-situ* method is needed. A phase-locked loop is used to make *in-situ* decay time measurements of the cavities. The presented method makes use of the extended adjusting capabilities of the S-DALINAC rf-input couplers to reach sufficiently low uncertainties of $\Delta Q_0/Q_0 < 10$ %.

AKBP 6.4 Di 14:30 BZ.08.06 (HS 1)

Optimization of SRF Cavities using State-Space Modeling — •Tomasz Galek, Johann Heller, Thomas Flisgen, and Ursula van Rienen — Universität Rostock, Institut für Allgemeine Elektrotechnik, Albert-Einstein-Str. 2, 18051 Rostock

The design of modern superconducting radio frequency cavities for acceleration of charged particle bunches requires intensive numerical simulations. A wide variety of parameters vital to the proper operation of accelerating cavities must be optimized. To compute properties of large and complicated RF structures a concatenation scheme is used. The aspects of concatenation using state-space Modeling and its application to the BESSY$^{\mathrm{VSR}}$ cavity chains is discussed.

AKBP 6.5 Di 14:45 BZ.08.06 (HS 1)

Surface study of centrifugal barrel polished 1.3 GHz Nb cavities — •Yegor Tamashevich[1,2], Eckhard Elsen[2], Brian Foster[1,2], Aliaksandr Navitski[2], and Alena Prudnikava[1,2] — [1]DESY, 22607 Hamburg, Germany — [2]University of Hamburg, 20146 Hamburg, Germany

Superconducting radio-frequency (SRF) cavities are the key components of accelerators such as the European X-ray Free Electron Laser and the planned International Linear Collider (ILC). Centrifugal barrel polishing (CBP) is a promising technique both for repairing and improving the performance of such cavities due to ability to remove large defects effectively and obtaining mirror-like surface without chemistry. In spite of numerous attempts, the CBP-treated cavities show yet worse SRF performance than expected. The present study explores the multistep recipe last developed at FNAL/JLab by using a coupon cavity with removable samples. It allows investigation of the interior surface after each polishing step by microscopic techniques such as laser profilometry, SEM/EDX, AFM etc. and measurement of the roughness and material removal rates at the most relevant areas. The study reveals some polishing media (e.g. Al2O3) to be embedded into the surface which causes new surface scratches in the final polishing step and * being normal conducting * most probably the worsening of the SRF performance. Additionally, a possibly detrimental shearing and deformation of the upper surface layer is observed. An improvement of the recipe is under study.

AKBP 6.6 Di 15:00 BZ.08.06 (HS 1)

ILC-HiGrade cavities as a tool of quality control for the EXFEL and further SRF R&D — •Aliaksandr Navitski[1], Yegor Tamashevich[1,2], Ricarda Laasch[1,2], Eckhard Elsen[1], Waldemar Singer[1], Jens Iversen[1], Axel Matheisen[1], and Detlef Reschke[1] — [1]DESY, 22607 Hamburg, Germany — [2]University of Hamburg, 20146 Hamburg, Germany

The order for superconducting radio-frequency (SRF) cavities for the European XFEL includes an additional set of 24 cavities which are part of the ILC-HiGrade program. Initially, these cavities serve as quality control (QC) sample extracted in parallel to the EXFEL cavities series production on a regular basis. These QC cavities include all processing steps of the EXFEL cavities and experienced identical treatment with the exception of mounting of the Helium vessel. After the normal acceptance tests at the cavity RF measurement facility, the cavities are removed from the production flow and subjected to further R&D studies and quality assurance (QA) tests. To maximize the information from these cavities, a temperature surface mapping technique is applied in the second cold RF test followed by a high-resolution optical inspection (OBACHT) of the inner cavity surface. These QA steps are carried out to improve the understanding of defects in close collaboration with the standing experts engaged in the EXFEL production. Correlations between cold RF tests, temperature mapping and optical surface quality help identifying limitations and provide valuable feedback for the production sequence. Results of the QC tests and R&D work will be presented and discussed.

AKBP 6.7 Di 15:15 BZ.08.06 (HS 1)

Second sound quench localization system for 1.3 GHz Nb cavities — •Ricarda Laasch[1,2], Yegor Tamashevich[1,2], Aliaksandr Navitski[2], Eckhard Elsen[2], and Brian Foster[1,2] — [1]University of Hamburg, 20146 Hamburg, Germany — [2]DESY, 22607 Hamburg, Germany

Precise localization and understanding of local thermal breakdowns or 'quenches' in 9-cell 1.3 GHz superconducting RF cavities are important steps in improving the performance of cavities, such as for the production of cavities for the European XFEL or the planned International Linear Collider. The 2nd sound method is a threshold technique that utilizes the phase transition of superfluid Helium induced during a quench and detected in Oscillating Superleak Transducers (OST). With several OSTs employed typical resolutions of ~1cm and better have been obtained. The number and position of sensors has to be optimized. The results are compared with a resistor-based temperature mapping system. Identified quench locations can be inspected for defects using the optical inspection system (OBACHT). Test results of several cavities will be shown.

AKBP 6.8 Di 15:30 BZ.08.06 (HS 1)

Studying Superconducting Samples with a Quadrupole Resonator — •Raphael Kleindienst, Jens Knobloch, Oliver Kugeler, Andrew Burrill, and Sebastian Keckert — Helmholtz-Zentrum-Berlin

Modern CW accelerators increasingly rely on superconducting cavities, which currently obtain quality factors well above 10^{10}, corresponding to surface resistances below 10 nΩ. To reach such high quality factors, all processes that can affect the material properties of either bulk niobium or thin superconducting films need to be thoroughly understood. Measuring the superconducting properties of flat samples in comparison to entire cavities is useful, as they are fabricated more easily, and the influence of geometric and mechanical effects is reduced.

Presently, only few facilities exist capable of measuring the surface resistance of superconducting samples with a resolution in the nano-ohm range over a wide temperature span. A dedicated test stand consisting of a Quadrupole Resonator (QPR) has therefore been constructed at the Helmholtz Zentrum Berlin (HZB).

Taking as a baseline the 400MHz QPR at CERN, the design was adapted and optimized to 433 MHz, making available the higher harmonic mode at 1,3GHz. After production by Niowave, the resonator was brought to Jefferson Lab for surface processing and a first RF test. The first cooldown with the complete assembly was performed in the new vertical test stand at HZB. The results for a large grain niobium sample are presented.

AKBP 6.9 Di 15:45 BZ.08.06 (HS 1)

High-Q cavity operation: Study on the thermoelectrically induced contribution to RF surface resistance — •Julia-Marie Vogt, Oliver Kugeler, and Jens Knobloch — Helmholtz-Zentrum Berlin

We present a study concerning the operation of a superconducting RF cavity in horizontal testing with the focus on understanding the thermoelectrically induced contribution to the surface resistance. Starting a few years ago, we suggested a means of reducing the residual resistance by warming up a cavity after initial cooldown to about 20K and cooling it down again, a thermal cycle. In subsequent studies we demonstrated a manipulation of the residual resistance by more than a factor of 2. We postulated that thermocurrents during cooldown generate additinal trapped magnetic flux that impacts the cavity quality factor. Since serveral questions remained open, we present here a more extensive study including measurement of two additional passband modes of the 9-cell cavity (8/9 π and 1/9 π) that confirms the effect. We also discuss simulations that substantiate the claim. While the layout of the cavity LHe tank system is cylindrically symmetric, we show that the temperature dependence of the material parameters result in a nonsymmetric current distribution. Hence a significant amount of magnetic flux can be generated at the RF surface resulting in an increased surface resistance.

AKBP 6.10 Di 16:00 BZ.08.06 (HS 1)

Superconducting RF Cavity and Cryomodule Concept for Bessy-VSR — •Andrew Burrill, Wolfgang Anders, Jens Knobloch, Axel Neumann, and Adolfo Velez — Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Berlin, DE

The next step in the evolution of the Bessy-II Storage ring at Helmholtz-Zentrum Berlin is perhaps the most ambitious to date. This entails the installation of higher harmonic Superconducting RF (SRF) cavities that will allow for variable pulse length operation, delivering short and long photon pulses to all users simultaneously, without a decrease in beam current when compared to standard Bessy-II operation. The name of this project is Bessy-VSR (Variable pulse length Storage Ring) and the approach to delivering these long and short pulses simultaneously is unique, requiring two new SRF cavity designs as well as a new cryomodule in which the cavities will be installed. The entire cavity and cryomodule design begins from a blank piece of paper and presents many significant technical challenges that must be addressed, all stemming from how to operate these new SRF cavities in the 300 mA recirculating electron beam of the Bessy-II storage ring. In this talk I will address the technical challenges that are encountered in the cavity and cryomodule design and the plans to overcome them.